

Several species, among them our most common starfish (*Asterias rubens*), I have been unable to examine. The material of some of the species was rather scanty and was from a single locality only. This was the case with *Benthopecten spinosus* and *Dytaster agassizi*. The specimens examined of these two species (see the table, p. 402) have a disc-radius of 5–10 mm. and 6–12 mm. respectively\*, and seem to belong to the same year-class (group II.). The question regarding the age of the starfishes therefore needs further investigation.

XL.—*Synopsis of the American Species of Rana.*

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I. Toes pointed or with slightly swollen tips.

A. Glandular dorso-lateral fold absent or flat and ill-defined, or, if narrow and prominent, not extending to the hip; tympanum at least  $\frac{2}{3}$  diameter of eye, usually much larger, especially in males; tibia  $2\frac{1}{2}$  to 4 times as long as broad; toes  $\frac{3}{4}$  to entirely webbed; outer metatarsals separated by web nearly to the base; nasal bones in contact with each other or narrowly separated.

1. Male with internal vocal sacs; dorso-lateral fold absent or flat and very indistinct.

Vomerine teeth between the choanæ (rarely just behind them); first finger as long as or a little longer than second; tibio-tarsal articulation reaching tympanum or eye; heels meeting or slightly overlapping when the hind limbs are folded at right angles to the body; tibia  $2\frac{1}{10}$  to  $2\frac{1}{2}$  times in length from snout to vent; tip of fourth toe free; no dorso-lateral fold .....

*R. catesbiana*, Shaw.

Vomerine teeth between the choanæ; first finger a little shorter than second; tibio-tarsal articulation reaching tympanum

\* The material of *Benthopecten spinosus* has not a maximum; of *Dytaster agassizi*, on the other hand, there is a marked maximum at 9–10 mm. comprising 18 individuals (or 52·9 per cent. of the total number).

or eye; heels meeting or narrowly separated; tibia  $2\frac{1}{4}$  to  $2\frac{3}{5}$  times in length from snout to vent; web extending to tip of fourth toe; no dorso-lateral fold.

*R. grylio*, Stejn.

Vomerine teeth on a level with posterior borders of choanæ, or just behind them; first and second fingers equal; tibio-tarsal articulation reaching eye; heels meeting or slightly overlapping; tibia 2 to  $2\frac{1}{3}$  times in length from snout to vent; one or two phalanges of fourth toe free; dorso-lateral fold present or absent . . . . .

*R. septentrionalis*, Baird.

2. Male with internal vocal sacs; dorso-lateral fold usually very distinct; vomerine teeth between choanæ or just behind them; first finger as long as or a little longer than second; tibio-tarsal articulation reaching eye or between eye and tip of snout; heels overlapping; tibia  $1\frac{2}{3}$  to  $2\frac{1}{4}$  times in length from snout to vent; one or two phalanges of fourth toe free.

Dorso-lateral fold not extending beyond sacral region . . . . .

*R. clamitans*, Daud.

Dorso-lateral fold extending beyond sacral region . . . . .

*R. onca*, Cope.

3. Male with external vocal sacs; tympanum not larger than eye; first finger as long as or slightly longer than second; heels meeting or not.

Head as long as broad; tibio-tarsal articulation reaching tympanum; tibia  $2\frac{2}{3}$  to  $2\frac{3}{4}$  times in length from snout to vent; two phalanges of fourth toe free; no dorso-lateral fold . . . . .

*R. virgatipes*, Cope.

Head broader than long; tibio-tarsal articulation reaching tympanum or eye; tibia 2 to  $2\frac{1}{3}$  times in length from snout to vent; fourth toe webbed to the tip, or last phalanx free; usually a more or less distinct dorso-lateral fold . . . . .

*R. montezumæ*, Baird.

B. Glandular dorso-lateral fold very distinct, extending to the hip (exceptionally interrupted posteriorly); nasal bones widely separated from each other.

1. Outer metatarsals separated nearly to the base; toes obtusely pointed,  $\frac{2}{3}$  to nearly entirely webbed; tibio-tarsal articulation reaching eye, tip of snout, or a little beyond; tibia  $3\frac{1}{2}$  to  $5\frac{1}{2}$  times as long as broad,  $1\frac{2}{3}$  to  $2\frac{1}{5}$  times in length from snout to vent.

a. Male with vocal sacs.

Head as long as broad or a little broader or a little longer; interorbital space much narrower than upper eyelid; dorso-

lateral folds narrow or moderately broad, usually with interrupted folds or elongate warts between them; outer metatarsal tubercle absent or very indistinct; male with external or internal vocal sacs . . . . .

*R. halecina*, L.

Head as long as broad; interorbital space much narrower than upper eyelid; dorso-lateral folds very broad, with a pair of similar folds between them; outer metatarsal tubercle usually present; male with internal vocal sacs . .

*R. palustris*, Leconte.

*b.* Male without vocal sacs.

Head broader than long; interorbital space as broad as or narrower than upper eyelid; tympanum  $\frac{2}{3}$  to once diameter of eye; outer metatarsal tubercle absent or very indistinct . . . . .

*R. draytonii*, B. & G.

Head as long as broad or slightly broader than long; interorbital space narrower than upper eyelid; tympanum  $\frac{2}{3}$  to  $\frac{1}{2}$  diameter of eye; a more or less distinct outer metatarsal tubercle . . . . .

*R. aurora*, B. & G.

2. Web not penetrating beyond basal half of outer metatarsals.

*a.* Glandular dorso-lateral fold narrow or moderately broad; head moderately large; vomerine teeth on a level with or behind posterior borders of choanæ.

Tibio-tarsal articulation reaching tympanum or eye; tibia 3 to  $4\frac{1}{2}$  times as long as broad, 2 to  $2\frac{1}{2}$  times in length from snout to vent; toes  $\frac{2}{3}$  to nearly entirely webbed; inner metatarsal tubercle  $\frac{1}{4}$  to  $\frac{1}{3}$  length of inner toe; male without vocal sacs . . . . .

*R. pretiosa*, B. & G.

Tibio-tarsal articulation reaching tympanum or eye; tibia 3 to 4 times as long as broad,  $2\frac{1}{5}$  to  $2\frac{1}{2}$  times in length from snout to vent; toes  $\frac{1}{2}$  to  $\frac{2}{3}$  webbed; inner metatarsal tubercle  $\frac{1}{2}$  to  $\frac{2}{3}$  length of inner toe; male with internal vocal sacs . . . . .

*R. cantabrigensis*, Baird.

Tibio-tarsal articulation reaching beyond eye; tibia 4 to 5 times as long as broad,  $1\frac{2}{3}$  to 2 times in length from snout to vent; toes  $\frac{2}{3}$  to  $\frac{3}{4}$  webbed; inner metatarsal tubercle  $\frac{2}{3}$  to  $\frac{3}{4}$  length of inner toe; male with internal vocal sacs . . . . .

*R. silvatica*, Leconte.

*b.* Glandular dorso-lateral fold broad; vomerine teeth between the choanæ.

Head moderate, slightly broader than long, 3 to  $3\frac{1}{2}$  times in length to vent; loreal

region feebly oblique; tibio-tarsal articulation reaching eye; tibia  $4\frac{1}{3}$  to 5 times as long as broad,  $2\frac{1}{2}$  to  $2\frac{1}{2}$  times in length from snout to vent; toes  $\frac{3}{4}$  webbed; male without vocal sacs . . . .

*R. godmani*, Gthr.

Head very large, as long as broad or a little broader than long,  $2\frac{3}{4}$  to 3 times in length to vent; loreal region very oblique; tibio-tarsal articulation reaching anterior border of eye or between eye and nostril; tibia 4 to 5 times as long as broad,  $1\frac{3}{4}$  to nearly 2 times in length from snout to vent; toes  $\frac{1}{2}$  webbed; male with external vocal sacs.

*R. areolata*, B. & G.

Head very large, much broader than long,  $2\frac{1}{2}$  to  $2\frac{2}{3}$  times in length to vent; loreal region very oblique; tibio-tarsal articulation reaching tympanum or eye; tibia 3 to  $3\frac{1}{2}$  times as long as broad, 2 to  $2\frac{1}{4}$  times in length from snout to vent; toes  $\frac{1}{2}$  webbed; male with external vocal sacs . . . . .

*R. capito*, Leconte.

II. Toes ending in very small discs; outer metatarsals separated nearly to the base; interorbital space equal to or a little less than breadth of upper eyelid; nasal bones widely separated from each other.

A. Loreal region moderately oblique; toes entirely webbed or two phalanges of fourth free.

1. Tips of fingers swollen; vomerine teeth behind level of choanae; tympanum  $\frac{2}{3}$  to  $\frac{3}{4}$  diameter of eye; tibio-tarsal articulation reaching tip of snout or beyond; head broader than long.

No dorso-lateral fold; tympanum distinct; heels not overlapping; tibia  $1\frac{1}{2}$  to 2 times in length from snout to vent; no outer metatarsal tubercle; male without vocal sacs . . . . .

*R. tarahumarae*, Blgr.

Dorso-lateral fold, if distinct, very broad and flat and restricted to the anterior half of the body; tympanum feebly distinct, ill-defined; heels overlapping; tibia  $1\frac{3}{8}$  to  $1\frac{1}{2}$  times in length from snout to vent; an outer metatarsal tubercle; male with internal vocal sacs . . . . .

*R. boylii*, Baird.

A moderately prominent dorso-lateral fold, extending to the hip, its distance from its fellow, on the back,  $3\frac{1}{2}$  times in length from snout to vent; tympanum very distinct; heels overlapping; tibia  $1\frac{3}{4}$  times in length from snout to vent; no outer metatarsal tubercle . . . . .

*R. pustulosa*, Blgr.

2. Tips of fingers obtuse or rather pointed; vomerine teeth between choanæ; tympanum  $\frac{1}{2}$  to  $\frac{3}{8}$  diameter of eye; tibio-tarsal articulation reaching eye or tip of snout; tibia  $1\frac{3}{4}$  to  $2\frac{1}{2}$  times in length from snout to vent; dorso-lateral fold prominent, its distance from its fellow, on the back, 4 to  $5\frac{1}{2}$  times in length from snout to vent; no outer metatarsal tubercle; head as long as broad or a little broader than long; male with internal vocal sacs . . . *R. palmipes*, Spix.

B. Loreal region vertical or nearly so; toes  $\frac{2}{3}$  to  $\frac{3}{4}$  webbed; tips of fingers swollen; tympanum  $\frac{1}{2}$  to  $\frac{2}{3}$  diameter of eye; tibio-tarsal articulation reaching eye or between eye and tip of snout; heels overlapping; tibia 5 to 6 times as long as broad,  $1\frac{3}{4}$  to 2 times in length from snout to vent; dorso-lateral fold prominent, its distance from its fellow, on the back, 5 to 6 times in length from snout to vent; no outer metatarsal tubercle: head as long as broad or a little longer than broad; male without vocal sacs . . . . . *R. ceruleopunctata*, Stdr.

The American frogs all belong to the subgenus *Rana*, agreeing with the type-species, *R. temporaria*, L., in the structure of the pectoral arch (strong horizontal clavicles, omosternal style not forked at the base). I conceive the most primitive type as with large nasal bones in contact with each other and with the frontoparietals entirely covering the ethmoid; pointed, fully webbed toes with the outer metatarsals separated by web to the base; a distinct tympanum; no glandular dorso-lateral fold\*. I therefore regard the species grouped together in division I. A. of the above synopsis as nearest to this prototype; from this group I. B. 1. and II. seem to be directly and independently derived, probably also I. B. 2. *b.*; whilst I. B. 2. *a.* is obviously connected with I. B. 1. The species under Division II. are furthest removed from the prototype; I see no reason for regarding *R. boyllii* as nearly allied to the *Rana temporaria*, and it is connected with *R. palmipes* by *R. pustulosa*.

1. *Rana catesbiana*, Shaw, 1802.

*R. boans* (non L.), Lacep., 1788.—*R. mugiens*, Merr., 1820.—*A. scapularis*, pipiens, Harl., 1825.—*R. conspersa*, Leconte, 1855.

North America east of the Rocky Mountains, from Canada (Quebec, Ontario) to Florida and Texas.

2. *Rana grylio*, Stejneger, 1901.

Florida, Mississippi, and Louisiana.

\* Cf. Bull. Soc. Zool. France, 1918, p. 111.

3. *Rana septentrionalis*, Baird, 1855.*R. sinuata*, Baird, 1855.

Southern Canada and New York to Montana and Utah.

4. *Rana clamitans*, Daud., 1801.*R. clamata*, Daud., 1803.—*R. fontinalis*, Leconte, 1825.—*R. flaviviridis*, Harl., 1825.—*R. horiconensis*, Holbr., 1842.—*R. nigricans*, Agass., 1850.—*R. nigrescens, clamator*, Leconte, 1855.—*R. clamitans melanota*, Rhoads, 1895.

North America, east of the Rocky Mountains, from Canada (Quebec, Ontario) to Florida and Louisiana.

5. *Rana onca*, Cope, 1875.*R. draytoni onca*, Cope, 1889.—*R. fischeri*, Stejneger, 1893.

Utah and Nevada.

6. *Rana virgatipes*, Cope, 1891.

New Jersey (Atlantic City and Lakehurst) and North Carolina (Lake Ellis).

7. *Rana montezumæ*, Baird, 1855.*R. adrita*, Troschel, 1865.—*R. montezumæ concolor*, Cope, 1887.

Plateau of Mexico, Tabasco, Tehuantepec.

8. *Rana halccina*, L., 1766\*.*R. pipiens*, Schreb., 1782.—*R. utricularia*, Harl., 1825.—*R. oxyrhynchus*, Hallow., 1856.—*R. berlandieri*, Baird, 1859.—*R. forreri*, Bouleng., 1883.—*R. virescens*, Garm., 1884.—*R. halccina sphenoccephala, brachycephala, austriicola*, Cope, 1886.—? *R. trilobata*, Mocquard, 1899.—*R. omiltemana*, Günth., 1900.

North America as far north as 52°, not extending west of the Sierra Nevada, Mexico and Central America as far south as Costa Rica. Up to 8000 ft. altitude in Colorado, 8500 ft. in Mexico, 5000 ft. in Costa Rica.

It may be possible to define three principal varieties: *sphenoccephala*, Cope, *forreri*, Blgr., and *austriicola*, Cope (*lecontii*, Gthr., Brocchi, *nigricans*, Brocchi).\* This name, latinised by Linnæus from Kalu's 'Sillhoppertosser,' appears in the synonymy of *R. ocellata*.

9. *Rana palustris*, Leconte, 1825.

*R. pardalis*, Harl., 1825.

North America, east of the Mississippi.

10. *Rana draytonii*, B. & G., 1852.

*R. lecontei*, B. & G., 1853.—*R. nigricans*, Hallow., 1854.—*R. longipes*, Hallow., 1859.—*R. aurora draytonii*, Camp, 1917.

Western North America, from British Columbia to the mountains of Lower California, up to 4000 ft. altitude.

11. *Rana aurora*, B. & G., 1852.

*R. temporaria aurora*, Cope, 1883.—*R. agilis aurora*, Cope, 1886.

Washington Territory, Oregon, and California.

12. *Rana pretiosa*, B. & G., 1853.

*R. temporaria pretiosa*, Cope, 1889.—*R. pretiosa luteiventris*, H. B. Thoms., 1913.

North America, from the Rocky Mountains westwards, from British Columbia to California.

13. *Rana cantabrigensis*, Baird, 1854.

*R. cantabrigensis latiremis*, *evittata*, Cope, 1886.

Western North America, from Alaska and Great Bear Lake to British Columbia, Alberta, Assiniboia, Manitoba, Minnesota, and Illinois.

14. *Rana silvatica*, Leconte, 1825.

*R. pennsylvanica*, Harl., 1825.

Eastern North America, from Manitoba, Ontario, and Quebec to South Carolina.

15. *Rana godmani*, Gthr., 1900.

Costa Rica (Rio Sucio).

I cannot help thinking that *R. godmani* will prove to be

identical with *Levirana vibicaria*, Cope, 1894. Except for the presence of feebly developed vomerine teeth, the longer inner finger, and the more extensive palmation of the toes in the former, there is almost complete agreement between the descriptions of the two, which are from the same part of Costa Rica.

16. *Rana areolata*, B. & G., 1852.

*R. circulosa*, Rice & Davis, 1878.

Indiana, Illinois, Georgia, Texas.

17. *Rana capito*, Leconte, 1855.

*R. areolata esopus, capito*, Cope, 1886.

Georgia, Florida.

18. *Rana tarahumaræ*, Blgr., 1917.

Sierra Tarahumari, N.W. Mexico, about 3000 ft.

19. *Rana boylei*, Baird, 1854.

*R. pachyderma*, Cope, 1883.—*R. boylei muscosa, sierræ*, Camp, 1917.

Oregon and California, up to 11,500 ft. altitude.

20. *Rana pustulosa*, Blgr., 1883.

Ventanas in Durango, Mexico.

21. *Rana palmipes*, Spix, 1824.

*R. juninensis*, Tschudi, 1845.—*Ranula gollmeri*, Peters, 1859.—*R. clamata*, var. *guianensis*, Peters, 1863.—*Ranula affinis*, Cope, 1866.—*Pohlia palmipes*, Steind., 1867.—*Ranula brevipalmata, nigrilatus*, Cope, 1874.—*R. vaillanti*, Brocchi, 1877.—*Hylarana brevipalmata*, Brocchi, 1882.—*R. copii*, Bouleng., 1882.—*R. bonaccana, melanosoma*, Günth., 1900.—*R. brevipalmata rhoadsi*, Fowler, 1913.

Central and South America, from Southern Mexico to Pernambuco and Peru.

This frog is interesting as the only representative of the genus *Rana* in South America. Few species have been more misunderstood and have given rise to more discussion



than this *R. palmipes*, originally described from the Amazonian region of Brazil.

It has been made the type of a distinct genus (*Ranula*, *Pohlia*) by Peters and by Steindachner, and even referred to the Hylidæ by Günther (1867). Peters founded the genus *Ranula* on the feeble dentition: "Die Zähne des Oberkiefers sind so schwach und wenig zahlreich dass man sie erst bei genauer Untersuchung findet und am Gaumen fehlen sie ganz." The explanation is that *Ranula gollmeri* was described from a recently transformed young, from Caracas, measuring 50 mm. from snout to vent; of this I feel sure, having examined young from Pebas of exactly the same size with a short tail and toothless upper jaw. A second, larger specimen, also from Caracas, was described at the same time by Peters as *Rana affinis*, and regarded as so closely related to *R. temporaria* that it should perhaps rank as a local variety only. A little later, however, Peters recognized that the two supposed species were identical and correctly referred them to *R. palmipes*. In 1866, Cope took up the genus *Ranula* and defined it as the American representative of *Hylorana*, differing in the "important particulars of the incompleteness of the ethmoid arch, its superior plate being represented by cartilage." Cope, who maintained the definition up to the close of his labours, can only have examined young specimens, for in the adult the ethmoid is ossified exactly as in *Rana temporaria*.

Schlegel, Tschudi, and Duméril and Bibron referred *R. palmipes* to the synonymy of *R. esculenta*; Peters described another specimen as a variety of *R. clamitans*; Brocchi's *R. vaillanti* was described as allied to *R. mugiens*; whilst Günther (1900), overlooking the small terminal discs of the toes, compared his *R. bonaccana* to *R. clamitans* and *R. draytonii*.

## 22. *Rana cæruleopunctata*, Str., 1864.

*Ranula cæruleopunctata*, *chrysoprasina*, Cope, 1866.—*Hylarana cæruleopunctata*, Steind., 1867.—*Trypherosia chrysoprasinus*, Cope, 1868.—*Hylarana chrysoprasina*, Brocchi, 1882.

Nicaragua and Costa Rica, up to 4600 ft. altitude.